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Published:
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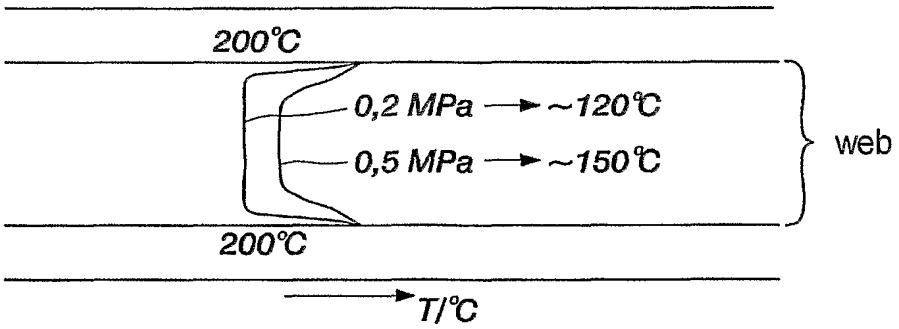
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A METHOD FOR TREATING A FIBROUS WEB



(57) Abstract: A method for treating a fibrous web with a belt calender, which comprises a belt arranged to circulate around at least one guide means, outside which belt is arranged at least one counterpart forming a contact surface with the belt, so that between the belt and the counterpart is formed a web calendering area through which the web to be treated is led. In the method, the temperature of the pressing surfaces is adjusted to a value which exceeds the boiling point of the liquid in the fibrous web corresponding to the pressure caused by the belt tension, the fibrous web to be calendered is led through the calendering area, whereby the surfaces of the calendering area conduct heat to the web, which vaporises the liquid, and the steam pressure increases to correspond to the external pressure caused by the surfaces. As the conduction of heat still continues, vaporisation continues, whereby the steam pressure causes the contact between the surface and the web to deteriorate, thus bringing about a state in the process where the surfaces of the web almost reach the temperature of the pressing surfaces, while the interior of the web is at a temperature corresponding to the pressure caused by the said belt tension, whereupon steep, internal thermal and moisture gradients are formed in the web.

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A method for treating a fibrous web

The present invention relates to a method for treating a fibrous web with a belt calender, which comprises a belt arranged to circulate around at least one guide means, outside which belt is arranged at least one counterpart forming a contact surface with the belt so that between the belt and the counterpart is formed a web calendering area through which the web to be treated is led.

The aim of the present invention is to provide a belt calendering process, where the bulk can be improved or better surface properties can be obtained with standard bulk than before.

To achieve this aim, the method according to the invention is characterised in that in the method, the temperature of the pressing surfaces is adjusted to a value which exceeds the boiling point of the liquid in the fibrous web corresponding to the pressure caused by the belt tension, that the fibrous web to be calendered is led through the calendering area, whereby the surfaces of the calendering area conduct heat to the web, which vaporises the liquid, and the steam pressure increases to correspond to the external pressure caused by the surfaces, and that as the conduction of heat still continues, vaporisation continues, whereby the steam pressure causes the contact between the surface and the web to deteriorate, thus bringing about a state in the process where the surfaces of the web almost reach the temperature of the pressing surfaces, while the interior of the web is at a temperature corresponding to the pressure caused by the said belt tension, whereupon steep, internal thermal and moisture gradients are formed in the web. The liquid may be water or an aqueous solution.

In a preferred implementation of the invention, the pressure caused by the belt tension is adjusted to a value within the range from below about 0.1 MPa to 1.5 MPa, the boiling point value of the liquid in the fibrous web corresponding to the said pressure value correspondingly being within the range from about 100°C to about 200°C respectively, and the temperature of the pressing surfaces is adjusted to a value exceeding about 200°C. In the test runs performed it was found that when the pressure caused by belt tension was adjusted to a value of about 0.2 MPa, when the temperature of the pressing surfaces was about 200°C, a 1-2%

better bulk was obtained than with a pressure of 0.5 MPa caused by the belt tension, when the temperature of the pressing surfaces was the same and the surface properties remained essentially the same. Similarly, when calendering under a pressure of 0.2 MPa caused by belt tension, while the bulk was constant, better surface properties were obtained than under a pressure of 0,5 MPa caused by belt tension. In connection with this application, the pressure caused by belt tension refers to the total pressure exerted on the web by belt tension and air pressure together.

The following may be mentioned as advantages of the method according to the invention:

- a lower pressure caused by the belt tension gives a higher thermal gradient on the web, whereby the inner parts of the web are worked less than the surfaces, from which follows the above-mentioned improvement of the bulk
- in a metal belt calender, in which the dwelling time is sufficient and moisture cannot escape from the web essentially otherwise than from between the pressing surface and the web, the process is self-corrective, that is, the contact between the web and the surfaces weakens because the belt tension is constant. This means that the pressure cannot rise above the set pressure, but the steam pressure is released from between the web and the pressing surface.

The temperature corresponding to each pressure caused by belt tension, above which temperature the surfaces should be, can be selected, for example, from a table illustrating the boiling point of water as a function of pressure, for example in the publication Kari I. Keskinen, Kemian laitetekniikan taulukoita ja piirroksia, p. 30-35. These values may be altered depending on the composition of the aqueous solution contained in the fibrous web, for example on the basis of test runs.

Another aim of the present invention is to provide a method for producing sterile paper or board.

The invention is described in greater detail in the following with reference to the accompanying drawings, in which:

Figure 1 shows diagrammatically a conventional soft calender arrangement,

Figures 2-3 show diagrammatically some modifications of the calender according to Figure 1,

Figure 4 shows diagrammatically a modification of a machine calender according to the prior art,

Figure 5 shows diagrammatically the temperature of the web at different points of its thickness, at two different pressure values caused by belt tension,

Figures 6-7 show the pressure distribution in metal belt calendering when using an internal additional load roll in the belt circulation, and

Figures 8-9 show the pressure distribution when using different combinations of metal belt calendering and machine calendering.

In the process according to the invention can be used, for example, the belt calender apparatus described in the FI application 20020159, with or without an additional load roll.

In addition to being used in new machines, the belt calender suitable for use in the method according to the invention can also be used in modernising paper/board machine calenders to replace previously used calender solutions.

Figure 1 shows a conventional soft calender arrangement which comprises a framework with a base part 2 to which are fixed vertical frames 3-5, of which the centremost 4 and 5 are connected at their top ends with a transverse bracket 6. In the framework is fixed, in a manner known as such, a thermo roll 8 and a flexible-surface roll 7, which form a calendering nip between them. In the example shown in Figure 1, there are two soft nips for treating both sides of the fibrous web in essentially the same manner. The apparatus 1 further comprises various guide rolls 9, 10, the operation of which is obvious to a person skilled in the art. Reference mark W illustrates the travelling of the fibrous web through the calender.

Figure 2 shows a modification of the two-nip soft calender according to Figure 1 with added metal belt circulations 11a and 11b, inside which are arranged guide rolls 12, that are preferably adjustable in location/position so that the tension and/or position of the belt 11a, 11b can be adjusted as desired. In Figure 2 (as well as in Figure 3), the same reference numerals have been used to denote the same parts as in Figure 1. Soft calender modernisation such as this makes possible the implementation of the present invention because of the sufficiently long treatment time. Figure 3 shows a modification of the soft calender of Figure 1, where one belt circulation 11 has been added and the other soft nip has been completely removed.

Figure 4 shows a machine calender with several conventional metal rolls 22 and one deflection compensated metal roll 21 connected to the frame part 20. In a normal machine calender, the fibrous web W travels from the nips between the metal rolls 22 and from the nip between the deflection compensated metal roll 21 and the metal roll 22 acting as its backing roll. In modernising a machine calender as shown in Figure 4, a metal belt circulation 11 is added to it and travels around the added guide rolls 12. The guide rolls 12 are preferably adjustable in location/position so that the tension and/or position of the belt 11 can be adjusted as desired. In such a case, the fibrous web will preferably travel through the long calendering area between the lowest metal roll 22 and the belt circulation 11. If so desired, the deflection compensated metal roll 21 can be used to form a point of higher pressure impact against the roll 22.

Figure 5 of the accompanying drawing shows diagrammatically the temperature of the web at different points of its thickness at two pressure values due to different belt tensions, when the temperature of the contact surfaces is about 200°C. According to the Figure, at the lower pressure of 0.2 MPa, the central part of the web reaches a value of about 120°C, whereas at the higher pressure of 0.5 MPa, the temperature of the central part of the web is about 150°C.

The lower the pressure caused by belt tension, the cooler the in interior of the web and the steeper the thermal gradients.

The lower the pressure caused by belt tension, the less working will take place in the inner parts of the web.

The more moist the web, the steeper the thermal gradients (vaporisation takes place in the thinner surface layer).

For the construction of the apparatus, the said process means small loads and tensions caused by the tension of the belt, and lightweight and inexpensive structures.

The food, pharmaceutical and cosmetics industries place increasingly strict demands on the sterility of packages. Plants manufacturing packaging papers and boards respond to the demands by polluting their plants' pulp and water circulation systems with various chemicals. Current paper or board production lines do not comprise such sub-processes, in which the whole thickness of the web could be subjected to sufficient temperature and pressure for killing microbes. Hospital equipment, for example, is sterilized by autoclave treatment at about 120-135°C and at a pressure of about 2 bars. The process according to the invention makes it possible to manufacture sterile paper/board without chemical treatments by subjecting the paper/board web to be treated thoroughly to a temperature exceeding about 110°C and a pressure exceeding about 0.1 MPa, caused by the belt tension. The pressure caused by belt tension that is exerted on the web is preferably within the range from about 0.1 MPa to 1.0 MPa, in which case the temperature of the web interior is within the range from about 110 to 170°C.

For example in the publication WO 03/064761 A1 are described various implementations of a metal belt calender, where the loading pressure exerted on paper or board may be effected by the tension of the metal belt and/or by using an additional load roll inside the belt circulation. The pressure effected by belt tension is typically within the range from 0.1 to 1 MPa. By means of the additional load roll are typically reached pressure levels ranging from 5 to 50 MPa. During the metal belt contact the paper or board warms up whereby it softens and calendering is facilitated. By means of the metal belt contact is, in addition, effected thermal treatment for the paper/board, which means that its surface is stabilised and will not be so sensitive to changes caused by moisture in further treatment (e.g. coating, printing, etc.). By using the additional load roll, a higher pressure nip area is formed inside the calendering area. Figure 6 shows a view in principle of the

pressure distribution in metal belt calendering, when the additional load roll is at the end of the metal belt contact, and Figure 7 shows the corresponding distribution when the additional load roll is at the beginning of the metal belt contact. The optimal position of the additional load roll depends on the paper or board grade to be calendered. If it is desirable to make the fibrous web to be treated denser, the arrangement according to Figure 6 is probably optimal. From the point of view of saving bulk, and when using the metal belt contact only for stabilising the surface of the fibrous web, the arrangement according to Figure 7 is probably better.

In accordance with the invention, the metal belt calender solution can be realised in such a way that the metal belt calender is only used to generate the pressure caused by belt tension for the thermal treatment of the fibrous web, and the higher pressure impact required by the pressing treatment is provided by means of a second calender located in conjunction with the metal belt calender, which may be, for example, a machine calender, a soft calender, a supercalender, a multi-roll calender, a shoe calender or a belt calender provided with an additional load roll. Figure 8 shows a view in principle of the pressure distribution when the metal belt calender is located before the machine calender producing the actual pressing action, and Figure 9 shows the corresponding distribution when the machine calender is before the metal belt calender. A combination of a metal belt calender according to the invention, where pressure is generated only through the tension of the belt, and a calender producing a separate, greater pressing impact is particular well suited to cases where the thermal treatment stabilising the surface of the fibrous web is the primary aim. An arrangement of this type is particularly well suited when providing a metal belt calender in an existing paper or board machine already comprising a machine calender or other calender. In such case, the existing calender may be utilised for effecting a pressing impact and, for example, in profiling, when the metal belt calender provides the thermal treatment of the fibrous web. The structure of the metal belt calender is simplified and becomes more economical as the additional load roll is left out from inside the metal belt circulation. Using a metal belt calender also reduces gloss mottling.

In the soft and machine calender modernisations shown in Figures 2 to 4, the metal belt circulation is added to an existing calender and it circulates around the added guide rolls. In these solutions, the roll forming the nip that was in the calender

previously is left inside the belt circulation, but the said roll remaining inside the belt circulation may also be left out. The metal belt circulation can conceivably be added before or after the existing set of rolls or roll nips. Modernisation can also be carried out by adding the metal belt calender before the calender already located on the line, or after it as a separate device.

Claims

1. A method for treating a fibrous web with a belt calender, which comprises a belt arranged to circulate around at least one guide means, outside which belt is arranged at least one counterpart forming a contact surface with the belt, so that between the belt and the counterpart is formed a web calendering area through which the web to be treated is led, **characterised** in that in the method, the temperature of the pressing surfaces is adjusted to a value which exceeds the boiling point of the liquid in the fibrous web corresponding to the pressure caused by the belt tension, that the fibrous web to be calendered is led through the calendering area, whereby the surfaces of the calendering area conduct heat to the web, which vaporises the liquid, and the steam pressure increases to correspond to the external pressure caused by the surfaces, and that as the conduction of heat still continues, vaporisation continues, whereby the steam pressure causes the contact between the surface and the web to deteriorate, thus bringing about a state in the process where the surfaces of the web almost reach the temperature of the pressing surfaces, while the interior of the web is at a temperature corresponding to the pressure caused by the said belt tension, whereupon steep, internal thermal and moisture gradients are formed in the web.

2. A method as claimed in claim 1, **characterised** in that in the method, the pressure caused by the belt tension is adjusted to a value within the range from about 0.1 MPa to 1.5 MPa, the boiling point value of the liquid in the fibrous web corresponding to the said pressure value correspondingly being within the range from about 100°C to about 200°C, and that the temperature of the pressing surfaces is adjusted to a value higher than the value of the corresponding boiling point.

3. A method as claimed in claim 1, **characterised** in that the temperature of the pressing surfaces is adjusted to a value exceeding about 200°C.

4. A method for manufacturing sterile paper or board, **characterised** in that in the method is used a metal belt calender, which comprises a metal belt (2) arranged to circulate around at least one guide means (3), outside which belt is arranged at least one counterpart (5) forming a contact surface with the belt so that between

the belt (2) and the counterpart (5) is formed a paper or board web treating area through which the web to be treated is led, and that in the method, the web is subjected thoroughly to a temperature exceeding about 110°C and a pressure exceeding about 0.2 MPa.

5. A method as claimed in claim 4, **characterised** in that in the method, the temperature of the interior of the web is brought to a temperature within the range from about 110°C - 170°C, while the pressure exerted on the web is within the range from about 0.2 MPa – 1.1 MPa.

6. A calendering arrangement for calendering a paper or board web, **characterised** in that the arrangement comprises a metal belt calender added in conjunction with a calender already existing in a paper or board machine line, or in front of or behind the said calender, the said metal belt calender comprising a metal belt arranged to circulate around at least one guide means, outside which belt is arranged at least one counterpart forming a contact surface with the belt, so that between the belt and the counterpart is formed a web calendering area through which the web to be treated is led, whereby the metal belt calender is arranged to generate only the loading force caused by the belt tension on the web conducted through the calendering area, while the calender already on the line is arranged to generate a point of higher pressure impact on the web to be calendered.

7. An arrangement as claimed in claim 6, **characterised** in that the metal belt calender is realised by replacing one nip roll of an existing calender with metal belt circulation, whereby the backing roll of the removed nip roll acts as the said counterpart.

8. An arrangement as claimed in claim 6, **characterised** in that the calender already on the line is a machine calender and that the metal belt calender is mounted before the machine calender.

9. An arrangement as claimed in claim 6, **characterised** in that the calender already on the line is a machine calender and that the metal belt calender is mounted after the machine calender.

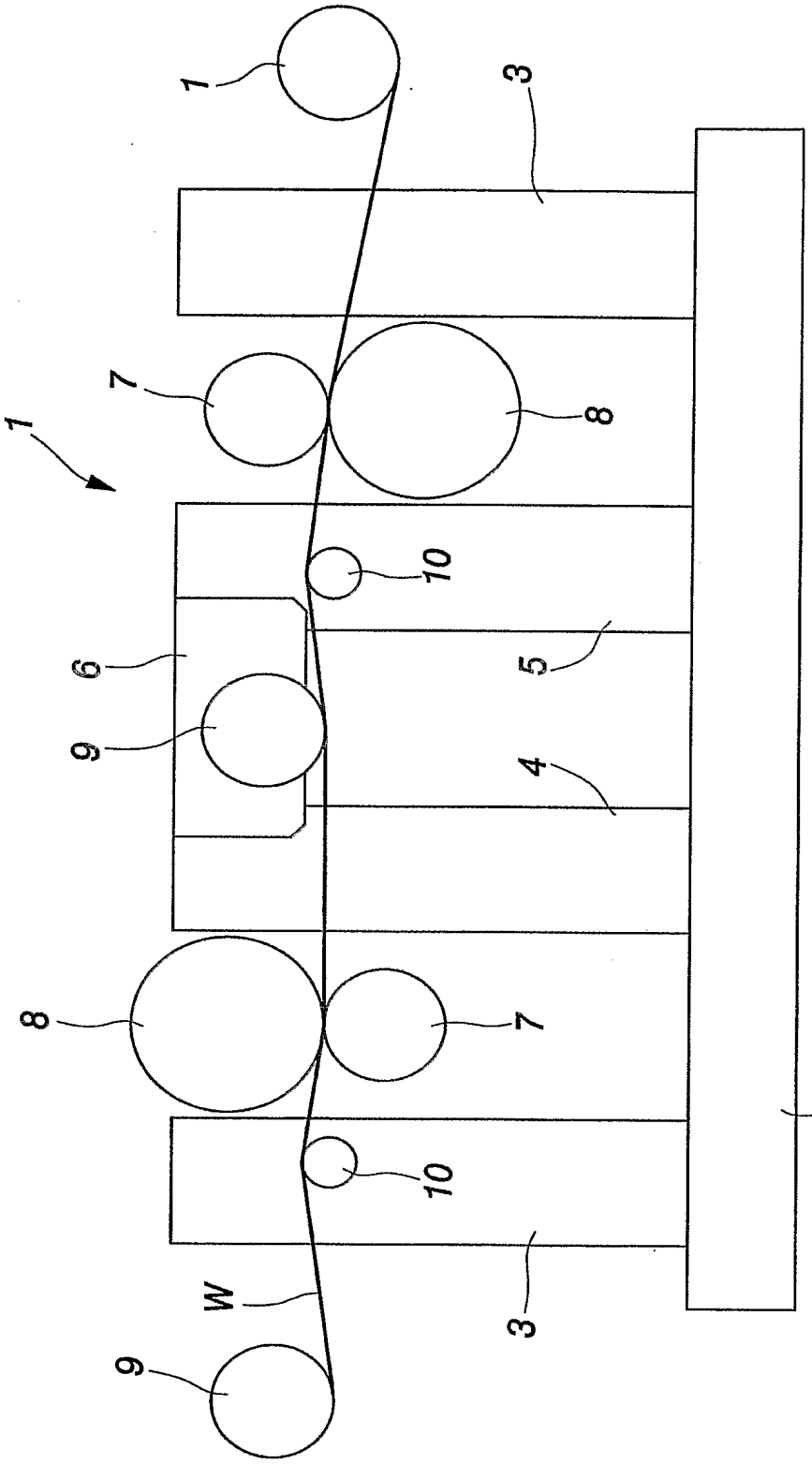

Fig. 1 (Prior art)

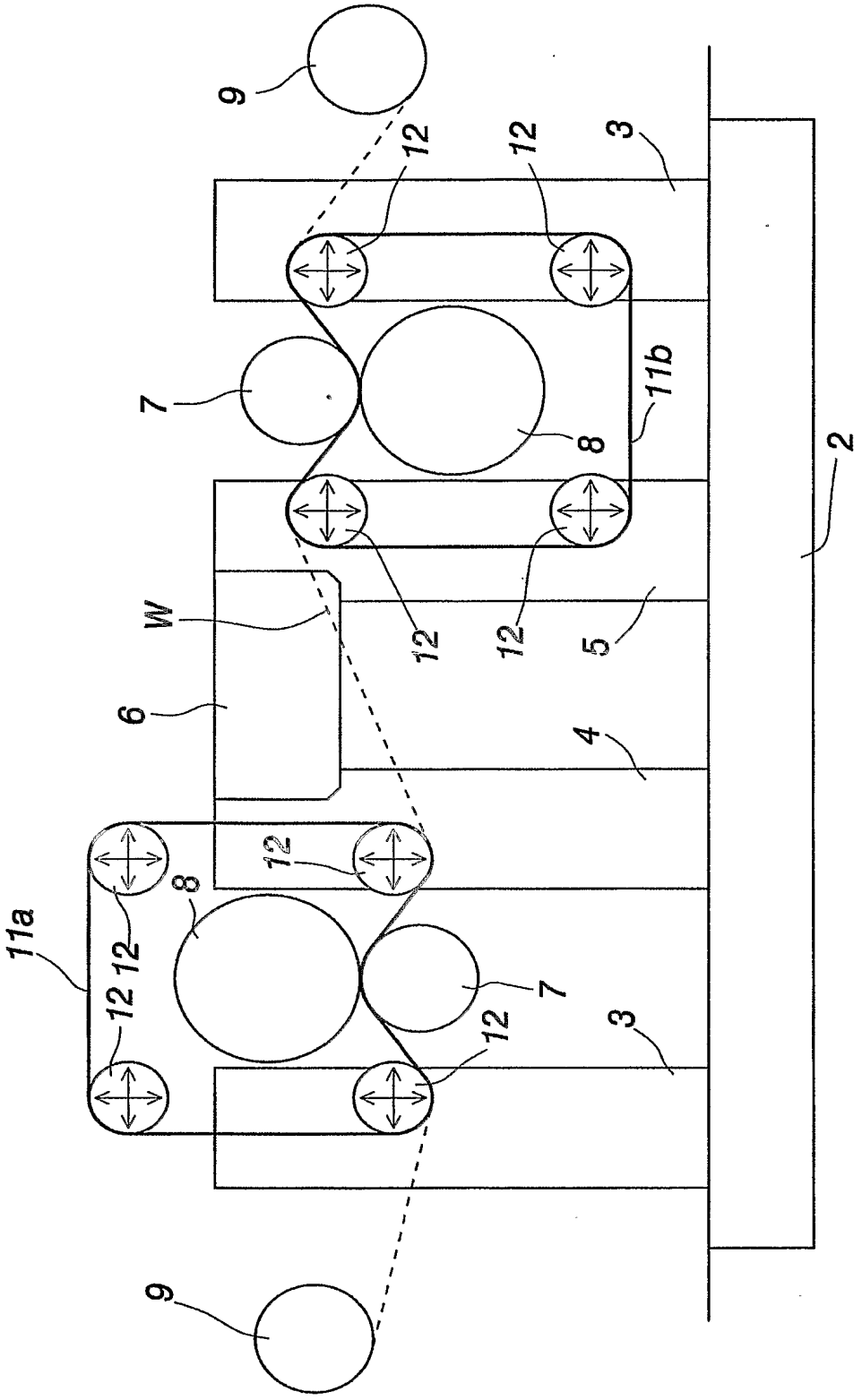

Fig. 2

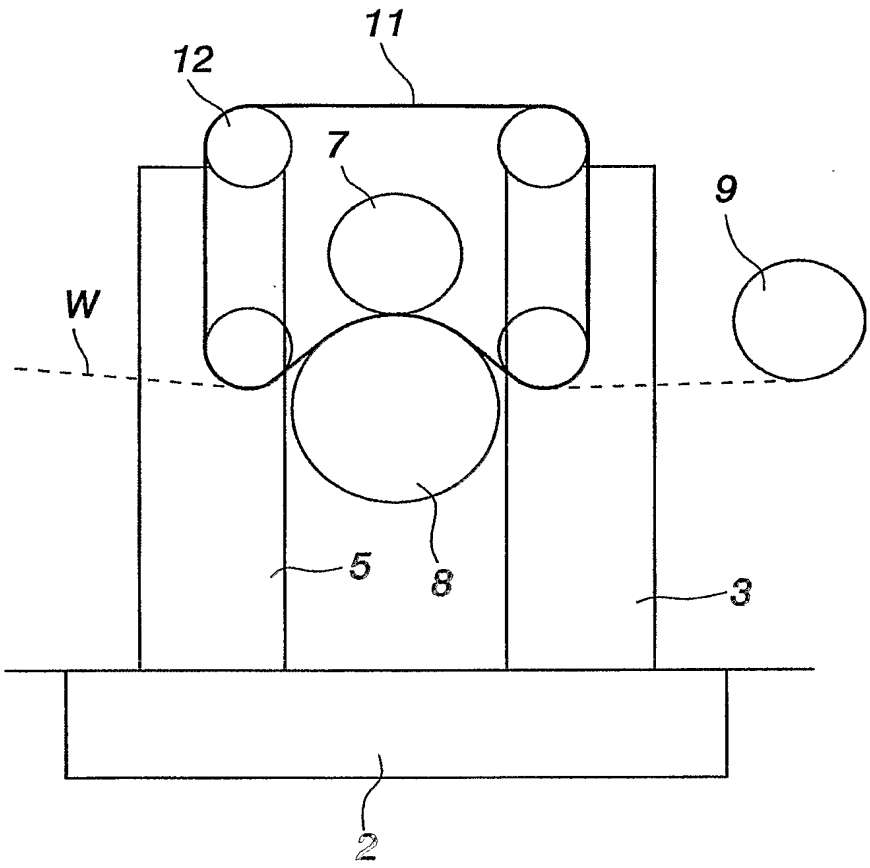

Fig. 3

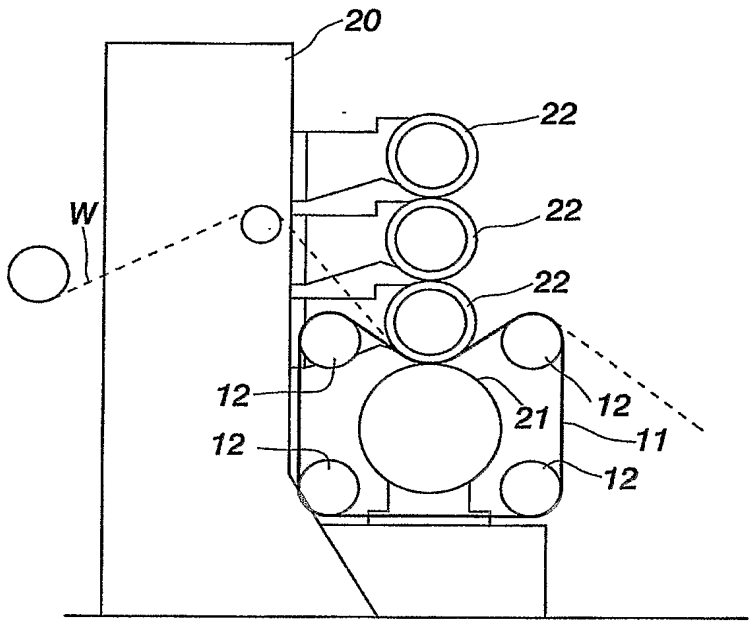
20
22
22
22
W
12
12
21
12
11
12

Fig. 4

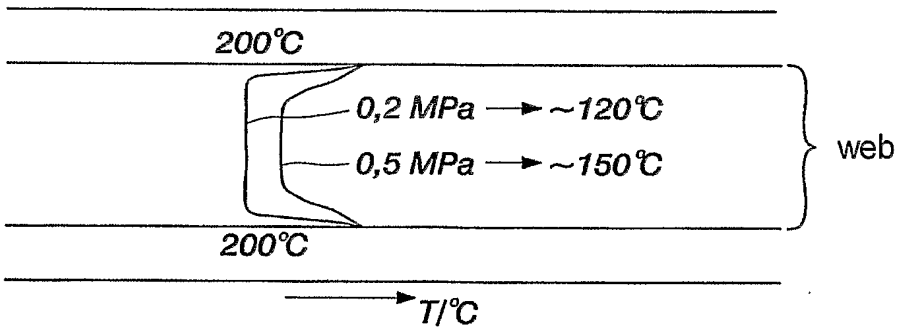
200°C
0,2 MPa → ~120°C
0,5 MPa → ~150°C
web
200°C
T/°C

Fig. 5

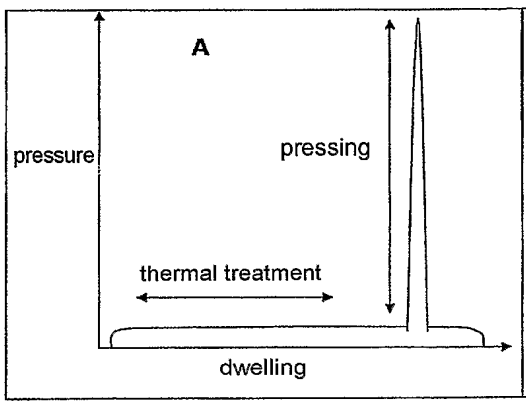

Fig. 6

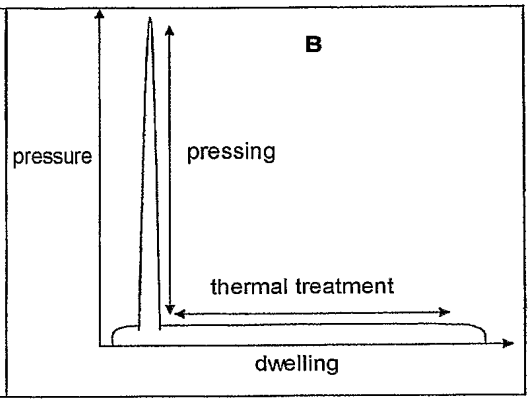

Fig. 7

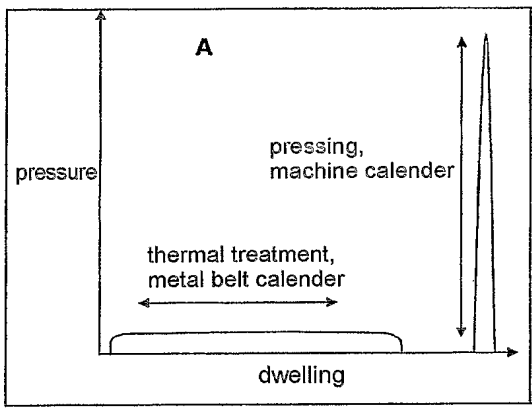

Fig. 8

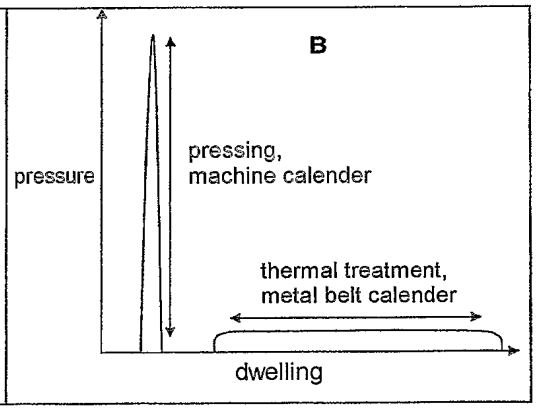

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 2004/050013

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21G 1/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 9844196 A1 (VALMET CORPORATION), 8 October 1998 (08.10.1998), page 9, line 15 - page 10, line 27; page 14, line 6 - line 9, figure 2, abstract	1-5
X	page 9, line 15 - page 10, line 27; page 14, line 6 - line 9, figure 2, abstract	6-9
	--	
Y	WO 0229159 A1 (METSO PAPER, INC.), 11 April 2002 (11.04.2002), page 4, line 21 - line 30, abstract	1-5
	--	
A	WO 8702722 A1 (SCOTT PAPER COMPANY), 7 May 1987 (07.05.1987), figures 6-9, abstract	1-9
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 June 2004	17 -06- 2004
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Nils Nordin/Els Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 2004/050013

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5245920 A (HARALD HESS), 21 Sept 1993 (21.09.1993), abstract -- --------	1-9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 2004/050013

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Invention I (claims 1-5)

Invention II (claims 6-9)

See next page

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 2004/050013

Invention I: (claims 1-5) The invention according to claims 1-5 concerns a method for treating a web in a belt calendar. The pressure caused by the belt tension is adjusted to a value within the range from about 0.1 MPa to 1.5 MPa and the temperature of the pressing surface is adjusted to a value higher than the value of the corresponding boiling point of the liquid in the web.

Invention II: (claims 6-9) The invention according to claims 6-9 concerns a calendering arrangement where a metal belt calendar is added in conjunction with an already existing calendar in a production line.

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/04/2004

International application No.
PCT/FI 2004/050013

WO	9844196	A1	08/10/1998	AT	211197	T	15/01/2002
				AU	6503798	A	22/10/1998
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				FI	971343	D	00/00/0000
				JP	2001518150	T	09/10/2001
				US	6397739	B	04/06/2002
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				EP	1330573	A	30/07/2003
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				DE	3577894	D	00/00/0000
				EP	0245250	A,B	19/11/1987
				SE	0245250	T3	
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TITLE: A METHOD FOR TREATING A FIBROUS WEB

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ABSTRACT:

CHG DATE=20040928 STATUS=O>A method for treating a fibrous web with a belt calender, which comprises a belt arranged to circulate around at least one guide means, outside which belt is arranged at least one counterpart forming a contact surface with the belt, so that between the belt and the counterpart is formed a web calendering area through which the web to be treated is led. In the method, the temperature of the pressing surfaces is adjusted to a value which exceeds the boiling point of the liquid in the fibrous web corresponding to the pressure caused by the belt tension, the fibrous web to be calendered is led through the calendering area, whereby the surfaces of the calendering area conduct heat to the web, which vaporises the liquid, and the steam pressure increases to correspond to the external pressure caused by the surfaces. As the conduction of heat still continues, vaporisation continues, whereby the steam pressure causes the contact between the surface and the web to deteriorate, thus bringing about a state in

the process where the surfaces of the web almost reach the temperature of the pressing surfaces, while the interior of the web is at a temperature corresponding to the pressure caused by the said belt tension, whereupon steep, internal thermal and moisture gradients are formed in the web.